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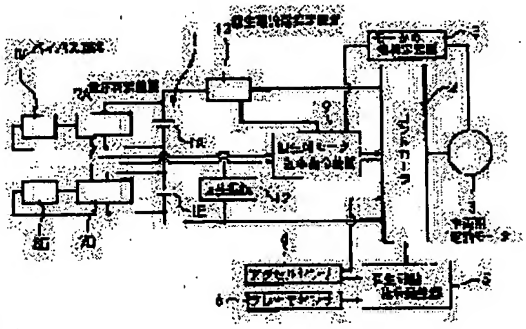
(54) REGENERATIVE BRAKE FOR ELECTRIC VEHICLE

(57)Abstract:

PURPOSE: To effectively prevent overcharging of a battery by sequentially controlling the regenerative current charging of the battery, the decrease of the regenerative efficiency, the consumption in a bypass unit and the consumption in a regenerative resistor in response to the increase of the battery voltage.

CONSTITUTION: When a regenerative brake command generator 5 instructs the start of regenerative brake, regenerative currents flow to batteries 1A, 1B for charging. A regenerative time motor efficiency specifying unit 9 decreases the regenerative efficiency of a motor 3 for driving a vehicle when the battery voltage reaches a first set voltage. When the charging of the battery is advanced and the battery voltage reaches a second set voltage, voltage deciding units 7A, 7B supply the regenerative currents to bypass circuits 8A, 8B corresponding to the voltage. When the batteries are fully charged, a regenerative current circuit specifying unit 10 supplies the regenerative current to a regenerative resistor 12. Thus, it is not necessary to increase the capacities of the regenerative resistor, the resistors of the bypass circuits, etc., thereby stably regeneratively braking while preventing the overcharging of the batteries.



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CLAIMS

[Claim(s)]
[Claim 1] Regenerative-braking equipment of an electric vehicle which is equipped with the following and characterized by being constituted in order of charge to said battery, decline in regeneration effectiveness, consumption with bypass equipment, and consumption by regeneration resistance according to increase of voltage of said battery so that consumption of regeneration current may be controlled. A drive motor A controller which controls this drive motor A battery used as a power supply of a drive motor Regeneration current path assignment [of passing regeneration current to regeneration resistance based on the command of a motor-efficiency director at a motor-efficiency director, the regeneration resistance which discharge regeneration current, and the time of said regeneration at the time of the regeneration which specifies the motor efficiency at the time of regeneration as the regenerative-braking command generator which gives a regeneration command to said controller, the voltage judging equipment which measure the voltage of said battery, and the bypass equipment which are connected to said battery at juxtaposition and pass regeneration current according to battery voltage] equipment
[Claim 2] While having the following and controlling consumption of regeneration current in order of charge to said battery, decline in regeneration effectiveness, consumption in a bypass circuit, and consumption by regeneration resistance according to increase of voltage of said battery It is regenerative-braking equipment of an electric vehicle which said regeneration effectiveness is made to improve when temperature of a drive motor becomes more than laying temperature, and is characterized by being constituted so that pyrexia of a drive motor may be lessened even if regeneration effectiveness falls. A drive motor A controller which controls this drive motor A battery used as a power supply of a drive motor A regenerative-braking command generator which gives a regeneration command to said controller, and voltage judging equipment which measures voltage of said battery, A bypass circuit which is connected to said battery at juxtaposition and passes regeneration current according to battery voltage, Heat judging equipment of a motor which judges temperature of said drive motor at the time of regeneration which specifies a motor efficiency at the time of regeneration to be a motor-efficiency director, regeneration resistance which discharges regeneration current, and regeneration current path assignment equipment which passes regeneration current to regeneration resistance based on a command of a motor-efficiency director at the time of said regeneration
[Claim 3] An ammeter which measures regeneration current is attached to said regeneration current path assignment equipment. A motor efficiency which a motor-efficiency director specifies at the time of said regeneration is expressed with a command current value, and regeneration current path assignment equipment compares a command current value which a motor-efficiency director specifies at the time of regeneration with a regeneration current value measured with said ammeter. Regenerative-braking equipment of an electric vehicle according to claim 1 or 2 characterized by being constituted so that the predetermined amount of current may be passed to said regeneration resistance when a regeneration current value is larger than a command current value.
[Claim 4] It is regenerative-braking equipment of the electric vehicle according to claim 3 characterized by for the amount director of bypass current which controls the amount of bypass current to be attached to said bypass circuit, and for the amount director of bypass current to compare the command current value which a motor-efficiency director specifies at the time of regeneration with the regeneration current value measured with said ammeter, and to be constituted so that the amount of current which flows in a bypass circuit may reduce, when a regeneration current value is smaller than a command current value.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the regenerative-braking equipment which used the motor for a drive of an electric vehicle.
[0002]
[Description of the Prior Art] In the electric vehicle which makes an electric motor the source of driving force, many regenerative-braking equipments which make the regeneration torque a part of damping force are used using the ability to use an electric motor as a generator at the time of un-driving in the case of braking. As this conventional kind of regenerative-braking equipment, there is a thing as shown, for example in drawing 7 . The controller 22 by which the accelerator pedal which is not illustrated steps on this, and it controls the output of a motor 23 by considering an angle etc. as an input between a motor 23 and a battery 21 is formed. And the regenerative-braking command generator 25 is further connected to the controller 22.
[0003] At the time of braking, based on actuation of a brake pedal etc., the regenerative-braking command generator 25 emits a regenerative-braking command, and the controller 22 is controlling the regeneration current supplied from a motor 23 according to this regenerative-braking command. Under the present circumstances, a controller 22 controls the regeneration current which flows to a battery 21 based on the voltage of a battery 21. There is some technique in this control and passing current is performed to that regeneration resistance that a battery 21 does not illustrate as 1 at the time of a full charge. As the 2, means by which a battery 21 worsens the regeneration effectiveness of a motor 23 in the full charge condition at the time of ******** may be taken. as a method of further others, the technology of passing regeneration current is also in bypass equipment, without charging the bypass equipment which is not in a battery 21 a drawing example at a battery 21, when installation and a battery 21 change into a full charge condition (for example, refer to JP,56-94906,A).
[0004]
[Problem(s) to be Solved by the Invention] However, with conventional regenerative-braking equipment, since only any one control of the above-mentioned control was performed, there were the following problems. First, since regeneration current cannot be changed to arbitration only in regeneration resistance, it becomes charge near constant-current charge, and a battery reaches charge termination voltage immediately, without the ability making many quantity of electricity charge. Since current must be consumed by regeneration resistance after that, the capacity of regeneration resistance itself will become large. Moreover, there is a problem that many quantity of electricity cannot be charged, either.
[0005] Moreover, since regeneration current cannot be changed only in bypass resistance, when a battery becomes a full charge, all regeneration current must be consumed by bypass resistance. Therefore, there is a problem that the capacity of bypass resistance will become very large. Furthermore, since the case of only changing the effectiveness of a motor must change regeneration effectiveness when the heat of a motor becomes more than laying temperature although regeneration current can be changed, a regeneration current value will become large. Therefore, battery voltage rises and the problem that many quantity of electricity cannot be charged is in a battery. Therefore, this invention aims at offering the regenerative-braking equipment of the electric vehicle with which regenerative braking moreover stabilized is obtained, solving such a conventional trouble and preventing the surcharge of a battery effectively.
[0006]
[Means for Solving the Problem] For this reason, a controller by which this invention according to claim 1 controls a drive motor and this drive motor, A battery used as a power supply of a drive motor, and a regenerative-braking command generator which gives a regeneration command to a controller, Voltage judging equipment which measures voltage of a battery, and a bypass circuit which is connected to a battery at juxtaposition and passes regeneration current

according to battery voltage, Regeneration resistance which discharges a motor-efficiency director and regeneration current at the time of regeneration which specifies a motor efficiency at the time of regeneration, It has regeneration current path assignment equipment which passes regeneration current to regeneration resistance based on a command of a motor-efficiency director at the time of regeneration. According to increase of voltage of a battery, in order of charge to a battery, decline in regeneration effectiveness, consumption with bypass equipment, and consumption by regeneration resistance, it should be constituted so that consumption of regeneration current might be controlled.

[0007] Invention according to claim 2 is equipped with heat judging equipment of a motor which judges temperature of a drive motor in addition to the above-mentioned configuration. While consumption of regeneration current is controlled in order of charge to a battery, decline in regeneration effectiveness, consumption in a bypass circuit, and consumption by regeneration resistance according to increase of voltage of a battery Even if regeneration effectiveness fell, when temperature of a drive motor became more than laying temperature, regeneration effectiveness should be made to improve, and it should be constituted so that pyrexia of a drive motor might be lessened.

[0008] Moreover, the regeneration current value measured with the command current value whose motor-efficiency director a motor efficiency which an ammeter which measures regeneration current to the above-mentioned regeneration current path assignment equipment is attached, and a motor-efficiency director specifies at the time of regeneration is expressed with a command current value, and specifies regeneration current path assignment equipment at the time of regeneration, and an ammeter compares, and the amount of current predetermined when a regeneration current value is large than a command current value can pass to aforementioned regeneration resistance. Furthermore, the amount director of bypass current which controls the amount of bypass current is attached to the above-mentioned bypass circuit, and a command current value which a motor-efficiency director specifies at the time of regeneration is compared with a regeneration current value measured with said ammeter, and the amount director of bypass current can reduce the amount of current which flows in a bypass circuit, when a regeneration current value is smaller than a command current value.

[0009]

[Function] In the thing of claim 1, if a regeneration command is given to a controller from a regenerative-braking command generator and regenerative braking is started, regeneration current will be first charged by the battery. If the voltage of a battery increases, a motor-efficiency director will reduce the regeneration effectiveness of a drive motor through a controller at the time of regeneration. If the voltage of a battery furthermore increases, regeneration current will be passed in a bypass circuit. And if the voltage of a battery increases further, for example, full charge voltage etc. is reached, regeneration current will be passed by regeneration resistance with regeneration current path assignment equipment.

[0010] The heat judging equipment of a motor is always detecting the temperature of a drive motor further, for example, even if it is in the condition of the above-mentioned regeneration degradation, the regeneration effectiveness is made to improve in the thing of claim 2, if it judges with having become beyond setting heatproof temperature. Thereby, pyrexia of a drive motor is reduced.

[0011] Moreover, form an ammeter and the command current value which a motor-efficiency director specifies at the time of regeneration is compared with the regeneration current value measured with an ammeter. When a regeneration current value is larger than a command current value and regeneration current path assignment equipment passes the predetermined amount of current to regeneration resistance When it originates in a gap of the responsibility of the regeneration effectiveness by rotation fluctuation of a drive motor etc. and excessive regeneration current arises, the charging current to a battery can be stabilized. furthermore, the thing for which the amount director of bypass current is formed, the command current value which a motor-efficiency director specifies at the time of regeneration is compared with the regeneration current value measured with said ammeter, and the amount of current to which the amount director of bypass current flows in a bypass circuit is reduced when a regeneration current value is smaller than a command current value -- regeneration current -- increase and decrease -- even if it changes in which direction, the charging current to a battery can stabilize.

[0012]

[Example] Hereafter, this invention is explained based on a drawing. Drawing 1 is the block diagram showing the example of this invention. In response to the accelerator command of the accelerator pedal by the accelerator sensor 4 which steps on and is expressed with an angle etc., in order to control the output of the motor 3 for a vehicles drive which uses a battery 1 as a power supply, a controller 2 determines parameters, such as a torque current value and an exciting-current value, and carries out the control drive of the motor 3 for a vehicles drive so that the torque corresponding to this may be outputted with maximum efficiency.

[0013] The regenerative-braking command generator 5 is connected to this controller 2. The accelerator sensor 4 and the

brake sensor 6 are connected to the regenerative-braking command generator 5, Accelerator OFF or Brake ON is detected in it, and the initiation command of regenerative braking is outputted to it. Under the present circumstances, it is contained while the necessity regeneration torque according to the amount of brake-pedal treading in orders in the necessity regeneration torque of engine brake, and Brake ON with Accelerator OFF. Moreover, the termination command of regenerative braking is outputted by subsequent Accelerator ON or motor rotational frequency zero.

[0014] A battery 1 is used as the group battery with which two single batteries 1A and 1B were connected and constituted from this example by the serial, regeneration current path assignment equipment 10 is formed between a battery 1 and a controller 2, and the regeneration resistance 12 is connected to regeneration current path assignment equipment 10 at a battery 1 and juxtaposition. The both-ends voltage is measured to each ** batteries 1A and 1B, respectively, and the voltage judging equipments 7A and 7B which judge a charge condition are attached to them. The voltage judging equipments 7A and 7B are equipped with a comparator or an operational amplifier inside, and they are constituted so that the regeneration current which will input the voltage of each measured ** batteries 1A and 1B through regeneration current path assignment equipment 10 as compared with the reference voltage (the 2nd programmed voltage) set up beforehand if the direction of battery voltage becomes high may be passed to the bypass circuits 8A and 8B equipped with resistance, respectively.

[0015] The heat judging equipment 13 of the motor which judges the temperature of the motor concerned under regeneration is attached to the motor 3 for a vehicles drive. It connects with a controller 2, the voltage judging equipments 7A and 7B, and the heat judging equipment 13 of a motor, the motor-efficiency director 9 is formed at the time of regeneration, and the output is inputted into regeneration current path assignment equipment 10 and a controller 2.

[0016] At the time of regeneration, the motor-efficiency director 9 defines the regeneration effectiveness of the motor 3 for a vehicles drive corresponding to each battery voltage obtained from the condition (the motor rotational frequency, torque) and the voltage judging equipments 7A and 7B of the motor 3 for a vehicles drive at the time of regenerative braking, and holds the effectiveness command value as a map which makes a parameter a motor rotational frequency, torque, and battery voltage. And if the battery charge voltage at the time of regenerative braking becomes high to the 1st programmed voltage lower than the 2nd programmed voltage of the above, the regeneration effectiveness of the motor 3 for a vehicles drive will be reduced. An effectiveness command value is expressed as a current value.

[0017] Next, an operation of each equipment is explained. Each command of torque current and an exciting current according to a rotational frequency and torque is issued from a controller 2 by the motor 3 for a vehicles drive. As for the motor 3 for a vehicles drive, the thermometry is always carried out by the heat judging equipment 13 of a motor during transit of vehicles. As mentioned above, the regenerative-braking command generator 5 outputs a regenerative-braking termination command to a controller 2 based on Accelerator ON while it detects Accelerator OFF or Brake ON and outputs a regenerative-braking initiation command to a controller 2. The voltage judging equipments 7A and 7B compare battery voltage and the 2nd programmed voltage. If the battery voltage is larger, current will be passed in the bypass circuits 8A and 8B. The bypass circuits 8A and 8B consist of resistance.

[0018] At the time of regeneration, the time of a carrier beam makes the regeneration effectiveness of the motor 3 for a vehicles drive the signal of the purport that the temperature of the motor 3 for a vehicles drive became with the heat judging equipment 13 of a motor more than laying temperature improve, and the motor-efficiency director 9 lessens pyrexia of the motor 3 for a vehicles drive. On the other hand, when the voltage of Batteries 1A and 1B becomes as larger [than the set point] as possible from the voltage judging equipments 7A and 7B, the command to which the regeneration effectiveness of the motor 3 for a vehicles drive is reduced is transmitted to a controller 2. However, when the heat judging equipment 13 of a motor judges the temperature of the motor 3 for a vehicles drive to be more than laying temperature, priority is given to the judgment and the regeneration effectiveness of the motor 3 for a vehicles drive is made to improve.

[0019] A consumed part of the regeneration resistance 12 and consumed distribution of the motor 3 for a vehicles drive are shown in drawing 2 . Since the regeneration current absorbed amount (a part for battery consumption) which cannot be charged any more [of a dc-battery 1] is fixed, if the amount of motor consumption is large as shown in (a) of drawing 2 , the amount of resistance consumption will become small. Moreover, if the amount of motor consumption is small as shown in drawing 2 (b), the amount of resistance consumption will become large. Thus, the temperature of the motor 3 for a vehicles drive turns into beyond setting heatproof temperature with the heat judging equipment 8 of a motor, and when pyrexia is lessened by making the regeneration effectiveness of the motor 3 for a vehicles drive improve, the amount of motor consumption becomes small, and since a gone up part of regeneration current flows to the regeneration resistance 12, a consumed part in resistance becomes large in it.

[0020] The flowchart of drawing 3 - drawing 4 explains control action. First, at step 101, it confirms whether be in the

condition of Accelerator OFF or Brake ON, if it is in the condition of Accelerator OFF or Brake ON, it will progress to step 102, otherwise, it returns from the detection result of the accelerator sensor 4 and the brake sensor 6 to origin. At step 102, the regenerative-braking command generator 5 emits the initiation command of regenerative braking according to the amount of brake treading in at the time of the brake ON of engine brake at the time of Accelerator OFF. By this, the regeneration command outputted from the regenerative-braking command generator 5 is inputted into a controller 2, controls the motor 3 for a vehicles drive, and regeneration is started.

[0021] At step 103, the regeneration current which the motor 3 for a vehicles drive generated is charged to Batteries 1A and 1B. At step 104, it checks, and if it is more than the 1st programmed voltage whether battery voltage turned into more than the 1st programmed voltage, it will progress to step 105. Otherwise, the charge to return and Batteries 1A and 1B is continued to step 103. At step 105, the motor-efficiency director 9 emits a command at the time of regeneration, and a controller 2 reduces the regeneration effectiveness of the motor 3 for a vehicles drive.

[0022] After this, at step 106, it progresses to step 109, and it checks with the voltage judging equipments 7A and 7B, and if it is more than the 2nd programmed voltage whether it became more than the 2nd programmed voltage with battery voltage higher than the 1st programmed voltage, it will progress to step 107. Otherwise, charge is continued.

[0023] At step 107, regeneration current is passed in the bypass circuits 8A and 8B connected to Batteries 1A and 1B at juxtaposition. Then, at step 108, it is confirmed for battery voltage whether to be the voltage at the time of a full charge. If it progresses to step 109 and has not reached at this step 108 when battery voltage has reached the voltage at the time of a full charge (charge beginning-and-the-end voltage), the check of step 108 is repeated. At step 109, while being adjusted so that the damping force of the whole vehicles may not change even if a cell becomes a full charge by passing all regeneration current to the regeneration resistance 12 including the current which was flowing on the cell, regeneration current is passed and consumed by the regeneration resistance 12.

[0024] In addition, in addition to these processings, there are two interruption processings performed for every predetermined time. The processing of one of these is processing shown by the flow of drawing 5 , processing starts it for every predetermined time, at step 111, the temperature of the motor 3 for a vehicles drive is measured, and it is confirmed for motor temperature by the heat judging equipment 13 of a motor whether to be beyond setting heatproof temperature. Step 111 will be repeated if motor temperature is lower than setting heatproof temperature. At the time of regeneration, on the other hand, with the check in step 111, if motor temperature is setting heatproof more than temperature, for example, 200 degrees C, it will progress to step 112, the motor-efficiency director 9 emits a command, the regeneration effectiveness of the motor 3 for a vehicles drive is gathered, and a controller 2 is controlled to lessen pyrexia.

[0025] And in step 113, regeneration current path assignment equipment 10 calculates a part for the current which gathered effectiveness and increased based on the command current value from the motor-efficiency director 9 at the time of regeneration, and passes a part for the regeneration current rise to the regeneration resistance 12. In addition, priority is given and processing of steps 112 and 113 is processed, even if processing of drawing 3 and drawing 4 is performed at the coincidence term. Although especially processing of another side is not illustrated, the detection condition and motor rotational frequency of an accelerator sensor are checked for every predetermined time, and regenerative braking will be completed if it is Accelerator ON (the accelerator pedal is stepped on) or motor rotational frequency zero. In addition, even if processing of drawing 3 and drawing 4 is also performing this processing at a coincidence term, priority is given and it is processed.

[0026] This example is constituted as mentioned above, from the condition of consuming regeneration current with a whole-quantity battery, corresponding to battery voltage increasing according to transition of regenerative braking, first, it reduces the motor efficiency of the motor 3 for (1) vehicles drive, makes regeneration current small, and bypasses regeneration current also in the bypass circuits 8A and 8B after that [(2)] in addition to a battery. (3) And when battery voltage reaches charge beginning-and-the-end voltage, control in the order of not passing to a battery but passing regeneration current to the regeneration resistance 12. When the temperature of the motor for a vehicles drive which fell regeneration effectiveness becomes in the meantime beyond setting heatproof temperature, a gone up part of current according regeneration effectiveness to raising and it is passed by regeneration resistance by interruption.

[0027] Thereby, it is necessary to make neither regeneration resistance nor resistance of a bypass circuit into a mass thing, and stable regenerative braking is obtained most effectively, preventing the surcharge of a battery. that is, since regeneration current is large and the time amount to which it is necessary to enlarge bypass resistance, and regeneration current is flowing in the bypass circuit further is long in order to acquire the same effect as this example even when it is the same as a bypass circuit till the time of passing current if the bypass circuit in regeneration current consumption sequence and the location of change of a motor efficiency are changed, it becomes severe thermally. On the other hand, since the motor for a vehicles drive is always cooled by the fan for cooling, it is not necessary to add components

especially for motor cooling. Moreover, in order to consume many of regeneration current, large capacity is needed [especially at the time before effectiveness change, since current will always flow to regeneration resistance, it becomes severe thermally, and], when the sequence of passing regeneration current to the regeneration resistance 12 is not the last also for the resistance.

[0028] Drawing 6 shows the 2nd example of this invention. In addition to the configuration of the 1st above-mentioned example, this example controls that splitting according to fluctuation of regeneration current further. That is, while an ammeter 11 is formed between a battery 1 and a controller 2 at regeneration current path assignment equipment 10 and a serial, the amount director 14 of bypass current which controls a bypass circuit is added.

[0029] An ammeter 11 measures regeneration current at the time of regeneration. At the time of regeneration, the regeneration current value and command current value which receive the command current value as having transmitted to the controller 2 with the same motor-efficiency director 9, and are measured with an ammeter 11 are compared, and when a regeneration current value is larger than a command current value, as for regeneration current path assignment equipment 10, the predetermined amount of current is passed to the regeneration resistance 12. Moreover, battery voltage becomes more than the 2nd programmed voltage, and in the phase of passing regeneration current in the bypass circuits 8A and 8B, when it sways to the one where the regeneration current value measured with the ammeter 11 is smaller than a command current value, it controls to reduce the amount of current which flows in the bypass circuits 8A and 8B in the amount director of bypass current.

[0030] A fan may be prepared in the above-mentioned example. This aims at cooling, while current is flowing to regeneration resistance and bypass equipment (full charge condition). A cooling fan is formed in the regeneration resistance 12 and juxtaposition which were specifically shown in drawing 5 . And when the check result in step 108 of the flow shown in drawing 4 is Yes (Y) (at the time of a full charge), current is passed to a cooling fan at the same time it passes current to the regeneration resistance 12 with regeneration current path assignment equipment 10. Regeneration resistance and bypass equipment are cooled by doing in this way.

[0031] Moreover, the air-conditioner for vehicles other than a cooling fan may be used. In the case of an air-conditioner, an air diffuser is formed also in the installation part of regeneration resistance in addition to in the car. The air diffuser to this regeneration resistance is usually closed. And when the check result in step 108 of the flow shown in drawing 4 is Yes, an air-conditioner makes open the air diffuser to the above-mentioned regeneration resistance at the time of ON. On the other hand, after an air-conditioner turns ON an air-conditioner at the time of OFF, it is made to make the air diffuser to regeneration resistance open.

[0032] Since this example is constituted as mentioned above, when regeneration effectiveness changes according to change of motor rotation etc., Originate in a gap of a command and an actual effectiveness change etc., and while the effective value measured with the ammeter 11 is larger than the current command value from the motor-efficiency director 9 at the time of regeneration Since regeneration current is passed only for the large part to the regeneration resistance 12, and the amount of current to the bypass circuits 8A and 8B is reduced by regeneration current path assignment equipment 10 when a regeneration current value is small, by it, the effect that the current impressed to Batteries 1A and 1B is kept constant is acquired.

[0033]

[Effect of the Invention] In the regenerative-braking equipment of the electric vehicle with which this invention is equipped with a bypass circuit and regeneration resistance as above Form a motor-efficiency director and regeneration current path assignment equipment at the time of regeneration, and increase of the voltage of a battery is embraced. In order of the charge to a battery, decline in regeneration effectiveness, consumption with bypass equipment, and consumption by regeneration resistance, since regeneration current control and consumption shall be performed Making neither regeneration resistance nor resistance of a bypass circuit into a mass thing, and preventing the surcharge of a battery effectively, stable regenerative braking is obtained and it has effects, such as relaxation of the thermal conditions of the miniaturization of regeneration resistance etc., regeneration resistance, and bypass resistance.

[0034] Furthermore, by having heat judging equipment of the motor which judges the temperature of a drive motor, also in the condition of reducing regeneration effectiveness, when the temperature of a drive motor becomes more than laying temperature, the regeneration effectiveness can be made to be able to improve, and pyrexia of a drive motor can be lessened. When the ammeter which measures regeneration current is formed, a regeneration current value is larger than a command current value and regeneration current path assignment equipment passes the predetermined amount of current to regeneration resistance, moreover, further By forming the amount director of bypass current and reducing the amount of current which flows in a bypass circuit when a regeneration current value is smaller than a command current value, even if regeneration effectiveness changes according to change of rotation of a drive motor etc., the effect that the current impressed to a battery is kept constant is acquired.

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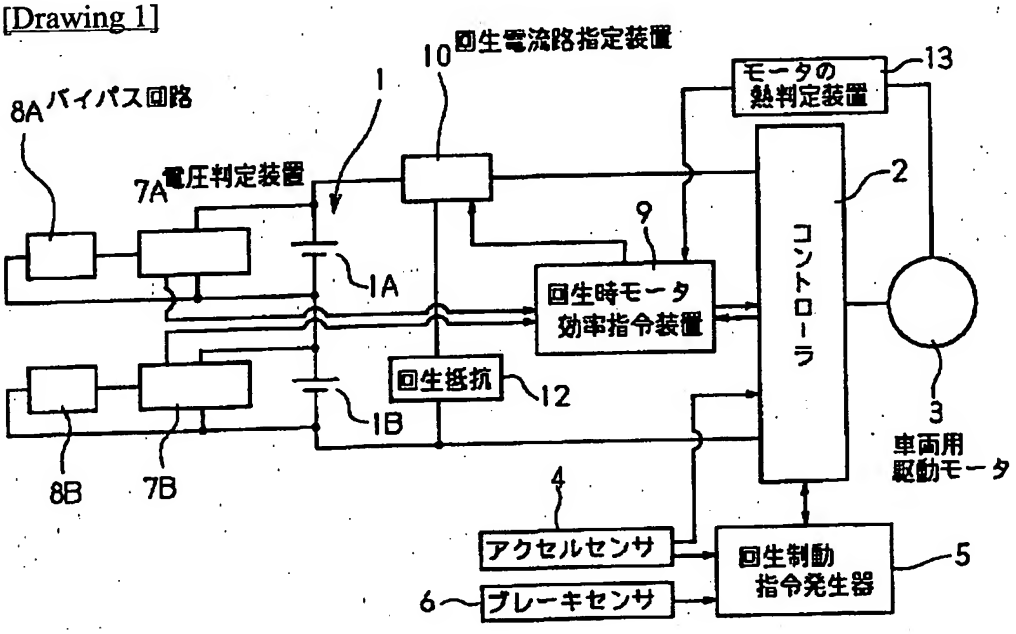
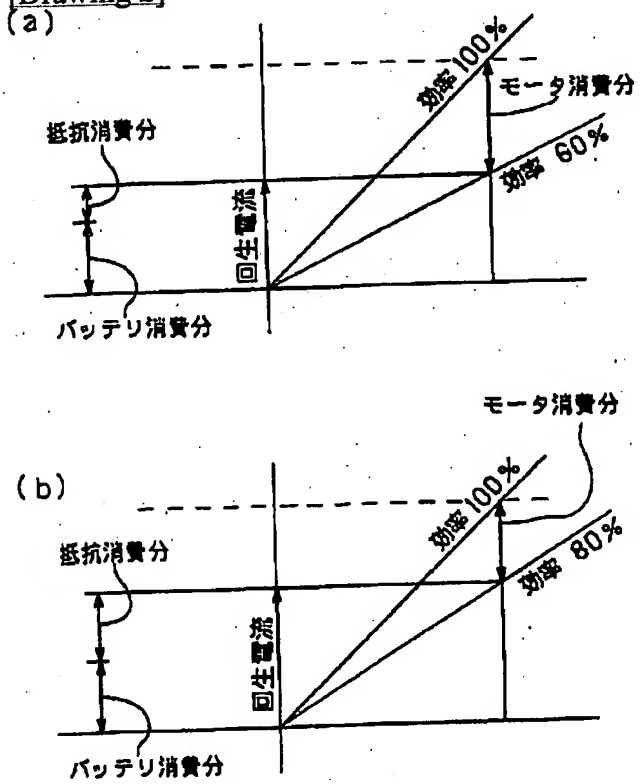
DRAWINGS

[Drawing 1]



[Drawing 2]



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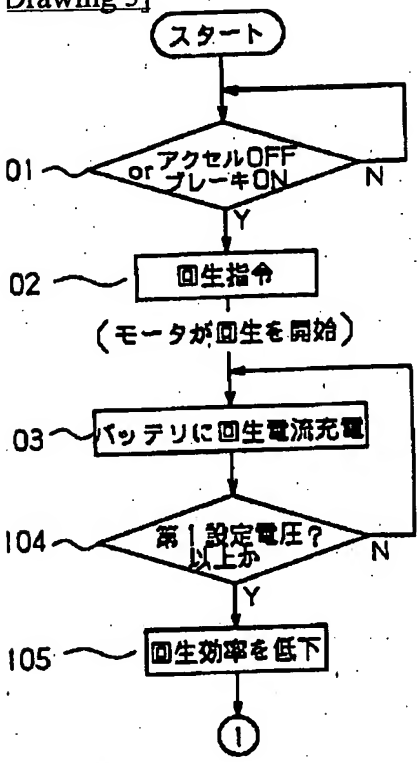

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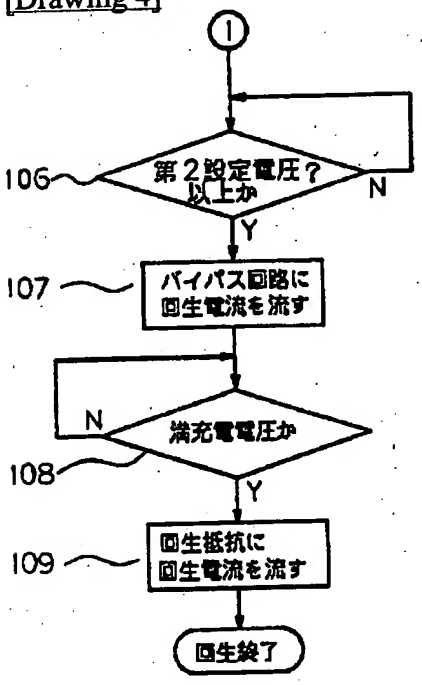

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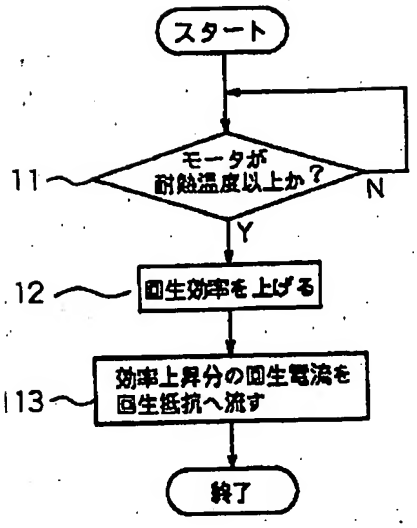

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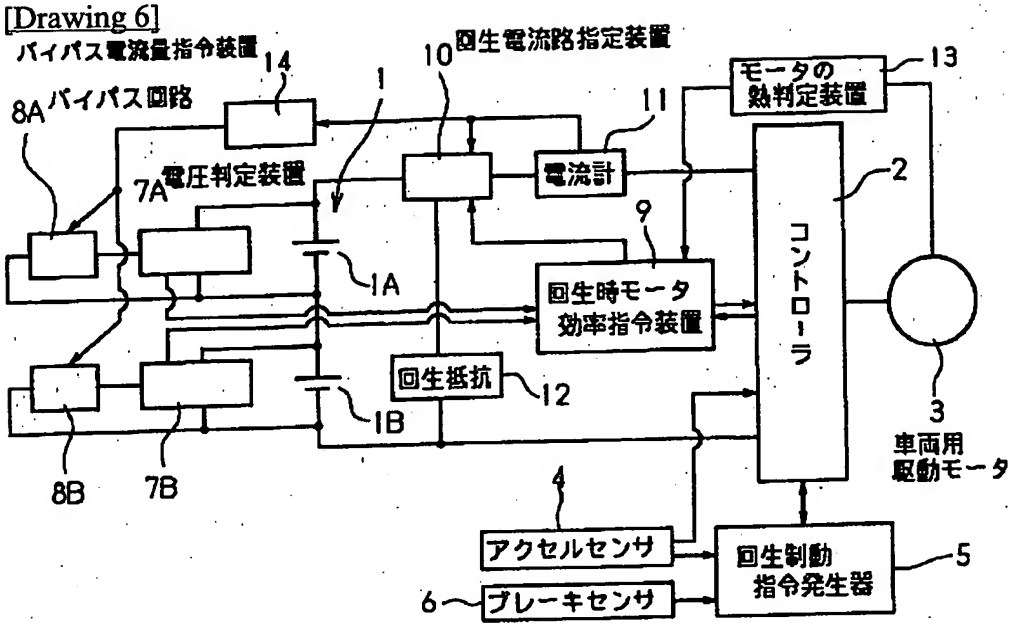
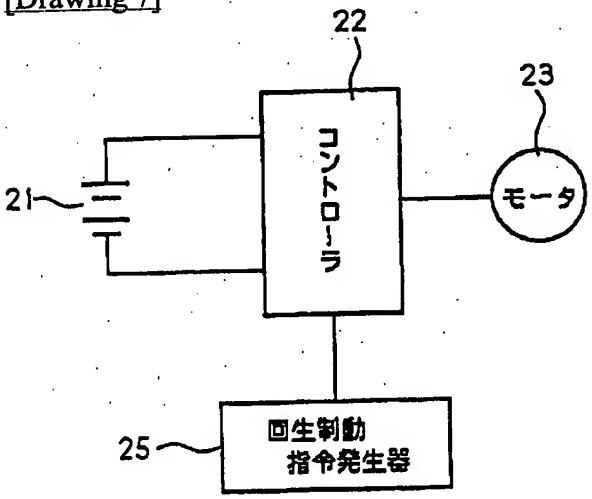


[Drawing 7]



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